

Use of software to aid irrigation

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Abstract— *Irrigation is a resource used by farmers to guarantee their production in regions where the rainfall regime is marked by extreme rainfall irregularity in time and space. Considering the great importance irrigation has for agriculture, especially in regions where the frequency of rainfall is irregular, it becomes as important as the knowledge of technical parameters of the crop, soil and climate to help producers in carrying out irrigation in a precise and less costly manner. There are different types of irrigation and different techniques used for good water management and resource saving. However, many of these tools and knowledge are not available to small producers because they are too expensive, not widespread or difficult to handle. Some technological tools have been emerging in recent years to help producers to perform irrigation based on technical parameters, one of these tools is software and applications that become a cheap and accessible alternative to the vast majority of producers. However, such software must be simple and intuitive so that it can be used by producers with little or no instruction.*

I. INTRODUCTION

The rainfall regime in arid and semi-arid regions is marked by extreme irregularity of rainfall in time and space. In this scenario, water scarcity constitutes a strong obstacle to socioeconomic development and even to the population's livelihood. Due to a history of inadequate use of water resources, associated with an increase in demand by various social and economic actors, as well as climate vulnerabilities, some areas of Brazil face situations of water scarcity, thus increasingly demonstrating the need for efficient planning of this common good - water, so important for the maintenance of life on planet Earth. Freshwater sources have suffered over the past hundred years from a set of human activities unprecedented in history. Irrigated agriculture is considered the human activity with the greatest consumption of water, and in-depth studies and specific research are increasingly

necessary, so that they can effectively contribute to the sustainability of irrigated agriculture.

Irrigation is a tool through which producers find a way to ensure their production, in the face of climatic phenomena and variations such as global warming. It is a costly tool when poorly sized and managed, which can reduce the company's profitability, as well as making its use unfeasible in certain cases [2]. The proper dimensioning of the irrigation system is of great importance, as the application of little water can lead to inadequate plant development, resulting in low productivity. On the other hand, providing more water than the crop needs can generate other problems for producers, such as the emergence and spread of diseases, waste of materials such as fertilizers and the increase in water and energy consumption, that is, an increase in production cost as a whole.

Irrigation has several technical parameters that, when combined with it, guarantee a better performance in execution, generating great benefits and little waste of resources. One of these parameters is evapotranspiration. Evapotranspiration is a natural process of loss of water from the soil and from the plant to the atmosphere, constituting a parameter of great relevance for the design and management of an irrigation system [9]. It is known that, for the proper management of irrigation water, it is necessary to control soil moisture and/or knowledge of evapotranspiration throughout the crop cycle. One of the main irrigation systems today is based on the calculation of evapotranspiration and water balance. An estimate of the evapotranspiration associated with the water balance equation allows the calculation of the soil water deficit, which is then compared to readily available water (RAW). When water depletion exceeds RAW, individual irrigation events generally return soil water containment (θ) to field capacity (θ_{fc}). When correctly applied, evapotranspiration-based irrigation scheduling practices have a long history of conserving water and maintaining crop yield and quality [Gu]. Therefore, knowledge of evapotranspiration enables the rational planning of the irrigation technique, which, associated with other meteorological elements, provides basic subsidies for the delimitation of areas more suitable for the development of certain groups of plant species [11].

Assessing the agroclimatic behavior of a certain location is the main step in agricultural scientific planning. Estimating the climatic water balance and climate classification are essential agroclimatic tools in determining the suitability of areas for agricultural crops and in planning irrigation systems [7]. Even with the water capacity of the region providing a great potential for irrigation, it is useless if the climatic behavior of the region is not previously studied and not even the quality of the soil analyzed. Thus, it is essential that parameters related to plants, soil and climate are known in order to determine the opportune time to irrigate and the amount of water to be applied.

Several technological innovations have been applied to agriculture as a whole. Automated control systems, autonomous harvesting machines, among others. In water management it is no different. Large standalone systems perform complex calculations and carry out irrigation accurately and efficiently. But systems like this come at a high price and are not accessible to all producers. So, some more economical alternatives have been appearing in the market, such as the use of applications to estimate calculations related to irrigation and water balance. These easy-to-access tools can produce valuable and accurate

information for producers. Applications can collect data from various sources over the internet, even if they require little or no user/producer intervention. Some possibilities arise when the producer shares his location with one of these apps (that is, the location of his farm), the app can then automatically search for data about the soil in the region, check rain forecast and collect it through the meteorological stations in the region, important data for the calculation of technical parameters that will certainly help and make irrigation more accurate and efficient.

II. MATERIALS AND METHODS

This research was based on a literary review, where scientific publications in related areas were consulted, valuing the multidisciplinary of the proposed theme. The main databases used were: IEEE, ResearchGate, Embrapa, Science Direct, among others.

The main keywords for the consolidation of this research were: water resources, software, application, irrigation, water balance, evapotranspiration. With the results obtained, a filter was made, framing the researched articles with the main focus of this work.

It was also appreciated, for the possibility of testing the analyzed applications, in addition to the main requirement of being free and available to the general public.

III. RESULTS AND DISCUSSION

Some apps provide data about a specific crop, others about the soil in a region. There are also those who propose to calculate the evapotranspiration of a given culture. Although disconnected, they are important information for irrigation management and bring enormous benefits to producers.

Considering all these data and calculations, climatological data, evapotranspiration, water balance, it is possible to gather them in a set of software with great application in irrigated agriculture. In this way, it enables producers to carry out water management based on technical parameters, providing better precision and greater savings in water and energy resources, among others.

[5] proposes a software for calculating evapotranspiration that uses the data entered in the program to calculate the reference evapotranspiration using the Penman-Monteith method. In Fig. 1, the main screen of the application is shown for the manual entry of climatological data relevant to the calculation of the equation.



Fig. 1: SMAI - Application proposed by [5]

The SMAI – Irrigated Agriculture Management System (*Sistema para Manejo da Agricultura Irrigada*, in portuguese) can be found through the link: <http://clima.feis.unesp.br/smai>. This software was developed during a research project by researchers from UNESP – Universidade Estadual Paulista and works exclusively on Windows platform. As it is a computer software, SMAI does not have great mobility or precision when it comes to localized data. Even using a notebook, the weather data must be entered manually, allowing for typing errors or even the insertion of data not corresponding to the desired area.

[10], in turn, presents an application for Android smartphones with the objective of calculating the climatological water balance. The application is no longer available on the platform's app store, however the author makes all the application's source code available through the website: <https://github.com/lucianoedipo/bhcmovel>. The application BHCMóvel - climatological water balance mobile (*Balanço Hídrico Climatológico Móvel*, in portuguese), follows some software engineering standards and good practices that were adopted during its development. However, as it is no longer available in an official store, its use and dissemination among producers is difficult. In Fig. 2, it is possible to see two distinct screens where the first is intended to receive the crop data and the second part, the soil data. However, all data must be manually entered by the user, which may lead the user to an error in data entry, either by typing or erroneous data collection, and possible propagation to the calculation results.



Fig. 2: Application proposed by [10]

Many applications have emerged in recent years for these purposes, achieving satisfactory results for the purposes of each application. As explained by [6], (the application) demonstrates to contribute to the execution of the various calculations, making the entire process, from obtaining the data to the generation of the final calculations, much more interactive and simple. And as demonstrated by [3], the application (...) worked satisfactorily, meeting all expectations, performing the Climatological Water Balance calculations correctly, presenting a simple interface for both data entry and display of results, also enabling the display of results in the form of tables or graphs.

Some applications provide data on a specific crop, others on the soil of a region and others, propose to calculate the evapotranspiration of a particular crop. Although disconnected, they are important information for irrigation management and would bring enormous benefits to producers. However, these applications can become unfeasible, when manipulated by people with low educational level, or with little contact with digital tools, a very common situation among family producers in Brazil. These applications do not have good usability as software engineering preaches, that is, they are not easy to use. As the author [3] explains in his work: the application makes it possible to calculate the Water Balance of Cultures, but for that it requires the user to have greater knowledge of the subject. This question, apparently forgotten by researchers and software developers, is extremely important so that the applications that will be developed are actually used by the target audience, that is, they will contribute and facilitate decision-making by producers, whether these are big or small producers.

IV. CONCLUSION

Surface irrigation is the widely used method of applying water to agricultural land where water is distributed to the field by surface flow. Despite its wide use, the method is characterized by low irrigation efficiencies and uniformity that can result in reduced crop productivity [1]. As discussed above, this efficiency can be increased with the use of tools that support decision making based on technical parameters.

For [8], the decision of when to irrigate can rarely be made using a single simple tool, but it is made through the integration of a range of different sources of information, such as:

- Soil moisture monitoring equipment;
- Experience and assessment of historical trends in river flow and precipitation;
- Symptoms of stress in plants, such as change in leaf color, withered plant, leaf temperature, among others;
- Current crop growth, fruit development, rooting depth and future climate.

The preservation of water resources concerns society as a whole. It is important to preserve these resources for the well-being of current society and future generations. In the same way that you have good ways to save water inside the homes in daily activities, it is necessary to transport these good ways to economic activities. And agriculture has a prominent role in this regard, as it is the human activity that consumes the most water in the world, and has a significant potential, if it adopts good practices, in the economy of water resources.

Therefore, technology has an important role to play in favoring the dissemination of accurate and direct information in favor of efficient irrigation management. The use of easily accessible technological tools can greatly contribute to the preservation of water resources. In the form of applications, these technological tools can be highly complex, gathering information from different databases and performing complex calculations, but for the user/farmer, all this complexity is transparent and the application is easy to handle and the information received be simple and straightforward.

Thus, it is undeniable the technological advances that agriculture has had in recent years, especially in the control of irrigation through the use of applications. They are low-cost alternatives that can significantly impact the lives of producers, especially small producers and family farmers. However, these alternatives must be accompanied by well-constructed software, not focusing exclusively on

the generation of data for water management, but taking care to obtain an extremely simple and intuitive product so that anyone can use it, even if this person has little or no education.

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